

Argan woodland: an important bird habitat in Morocco

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L'Arganeraie: un habitat important pour les oiseaux au Maroc. D'origine tropicale, l'Arganier *Argania spinosa* forme dans le sud-ouest du Maroc, région appartenant au secteur macaronésien, de vastes peuplements arborés qui constituent un habitat important pour les oiseaux. Cet habitat boisé, le plus méridional du paléarctique occidental, permet à certaines espèces d'oiseaux de nicher ou d'hiverner à une latitude bien plus basse que partout ailleurs en Afrique du nord. Dans cet article, nous décrivons en détail le milieu et les espèces nicheuses de l'arganeraie et abordons plus brièvement son importance pour les migrateurs et les hivernants européens. L'originalité du peuplement d'oiseaux nicheurs vient de la présence de plusieurs espèces d'origine tropicale parmi lesquelles deux taxons rares, l'Aigle ravisseur *Aquila rapax* et la sous-espèce endémique du Maroc de l'Autour-chanteur sombre *Melierax metabates theresae*. Tous deux sont menacés par la destruction ou la dégradation des formations matures d'Arganier. Nous recommandons que des recherches soient menées pour préciser leur statut actuel de façon à prendre les mesures de conservation appropriées.

The Argan tree *Argania spinosa* is endemic to Morocco and is the dominant tree in woodland over much of the south-west. It is a member of the tropical family, Sapotaceae, originating from Macaronesia (the Azores, Madeira, Canaries and Cape Verdes), which includes c.600 species and 50 genera. The Moroccan coast from Cape Cantin-Safi south to Ifni-Assaka is considered part of this region and shares many elements of its flora, including *Euphorbia beaumierana*, *E. echinus*, *Senecio antheuphorbium* and *Helianthemum canariense*, which occur in the Argan woodland. Argan woodland forms an important bird habitat that has rarely been mentioned in the ornithological literature. It represents the southernmost forest habitat in the Western Palearctic and enables woodland species to breed or winter much further south than elsewhere in North Africa.

Here, we describe the Argan habitat in detail, as many parts are now threatened by clearance for agriculture. We list all breeding birds using this unique habitat, and also mention the most noteworthy migrant and wintering species. Many of the general data on habitat are taken from Benabid (2000), Boudy (1950), Emberger (1939) and M'Hirit *et al.* (1998), and information on birds from records summarised in Thévenot *et al.* (2003). Additional data are included from several papers (e.g. Bannerman & Bannerman 1953, Heim de Balsac & Heim de Balsac 1954, Sage & Meadows 1965, Heinze & Krott 1979, Castell 2000), from the thesis of Rousseau (2000) and

from unpublished notes of Paul Chadwick, Raymond Lévêque, Bryan Sage and Ray Thomas.

The Argan habitat

The Argan tree

The Argan tree is one of the most important tree species in North Africa, both from a botanical and socio-economical point of view. It is long lived, with some trees known to be 200–250 years old. It superficially resembles an olive tree with a large, fine, spreading form and a dense canopy that can reach 8–10 m high if left unmanaged. The trunk is strong and short, with a rough bark. The leaves are dark green above and pale green below; they generally fall during very dry conditions (e.g. in 1980, 1991–92, 1992–93 and 2003). The tree

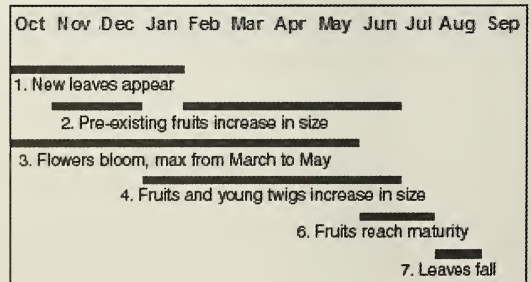


Figure 1. Phenological cycle of the Argan tree *Argania spinosa* (after M'Hirit *et al.* 1998)

Cycle phénologique de l'Arganier *Argania spinosa* (d'après M'Hirit *et al.* 1998)

flowers in spring and occasionally in the autumn, with fruits reaching maturity in June–July (Fig. 1).

Geographical distribution of Argan woodland

Argan woodland covers *c.* 550,000–828,000 ha (Emberger 1939, Boudy 1950, M'Hirit *et al.* 1998), which makes it the second-largest woodland area in Morocco, after Holm Oak *Quercus ilex* forest (1,400,000 ha) and more or less equivalent in size to Barbary Arbor-vitae *Tetraclinis articulata* forest (600,000–750,000 ha: M'Hirit *et al.* 1998, Thévenot *et al.* 2003). Argan is restricted to a large semi-arid region of south-west Morocco, where mean rainfall is only 100–400 mm p.a. (Emberger 1939). The largest areas occur from Safi in the Chiadma region (32°18'N), in the north, to the Oued Draa in the Lower Draa region (28°40'N) in the south, and include both the Souss plain and the High and Anti-Atlas foothills.

It reaches 1,500 m in the Anti-Atlas. A remnant population also perhaps persists in the Saquiat Al-Hamra in Western Sahara (Valverde 1957).

Argan habitat types

Several types of Argan habitat can be distinguished, which follow a gradient of aridity primarily governed by latitude and proximity of the Atlantic Ocean. Plant species characteristic of Argan woodland include *Acacia gummifera*, *Asparagus altissimus*, *Bupleurum dumosum*, *Chamaecytisus albidus*, *Linaria sagittata*, *Rhus tripartita*, *Warionia saharae* and *Periploca angustifolia* (Benabid 2000).

In the Haha region, where the High Atlas meets the Atlantic Ocean, the Argan reaches the coast on high cliffs and on headlands such as Cape Sim, Cape Tafelney and Cape Ghir, where it occurs with other trees, notably Wild Olive *Olea europaea* and Lentisc *Pistacia lentiscus*. South of Agadir, Argan woodland is largely influenced by the nearby Atlantic Ocean, with pre-steppe vegetation dominated by spurges *Euphorbia beaumierana*, *E. echinus*, *E. regis-jubae*, *Salsola longifolia* and *S. vermiculata*. Inland in the Souss Valley and the Anti-Atlas, the vegetation is more xerophytic with some *Acacia gummifera* and an understorey of mainly *Ziziphus lotus*, *Withania adpressa*, *Launaea arborescens*, *Senecio anteuphorbium* and *Genista ferox*.

At the edge of its range, the Argan comes into contact with Barbary Arbor-vitae *Tetraclinis articulata* and Phoenician Juniper *Juniperus phoenicea* both in the Haha, Chiadma and Abda regions, with Holm Oak *Quercus ilex* and Juniper *Juniperus oxycedrus* on the slopes of the Western High Atlas, and with *Acacia* sp. in pre-desert areas.

In its natural state, the Argan formed a dense forest with an understorey of impenetrable scrub where more than 1,000 species of vascular plants, including 140 Moroccan endemics, have been recorded (M'Hirit *et al.* 1998). But man has altered most, if not all, Argan woodland over many centuries. It now forms



Figure 2. Geographical distribution of the Argan tree *Argania spinosa* (after M'Hirit *et al.* 1998)

Répartition géographique de l'Arganier *Argania spinosa* (d'après M'Hirit *et al.* 1998)

an open parkland forest equivalent to the *Acacia* open woodland south of the Sahara, or even in some ways to the managed open cork oak woodlands in northern Morocco, southern Portugal and Spain. Locally, the understorey has totally disappeared due to excessive grazing or ploughing. As no regeneration occurs, the Argan forest here is on the verge of extinction.

The use of the Argan woodland by Man

For centuries, the traditional and lightest form of Argan woodland exploitation followed three different forms: cutting of branches for fuel, grazing by goats (who often climb trees), sheep and occasionally camels, and harvesting of fruits for cooking oil. Oil production was low: only 3.3 litres per 100 kg of dry fruit extracted manually, with each tree producing 8 kg of fruit per year.

In the early-20th century, branches and whole trees were cut to produce high-quality charcoal for the large cities, especially Casablanca, Marrakech and Safi, resulting in the destruction of 200,000 ha of woodland. In 1925, however, a law was passed to prevent the total destruction of this unique habitat. Nowadays timber production from Argan is still estimated at *c.* 400,000 m³ p.a., i.e. 13% of the national firewood production.

Since the 1950s, Argan woodland has suffered much clearance of the understorey, particularly in the lowlands, with the soil below ploughed occasionally for the production of cereals, especially barley. The overall ecological balance does not appear to have been much affected, however, as ploughing was performed with traditional tools that do not damage tree roots.

Since the 1980s, more intensive cultivation has commenced, especially in the rich fertile plain of the Souss Valley, where the mild climate and extensive use of irrigation has permitted a wide range of crops, especially citrus and olive plantations, resulting in severe fragmentation of some of the dominant stands of Argan.

As an example, Table 1 shows the changes in the Argan forest of Ademine, between 1969 and 1986 (El Yousfi & Benchekroun 1992, M'Hirit *et al.* 1998). This forest stretches for 35 km on the south side of Oued Souss, between Ait-Melloul and Ida-Ou-Mennou, and is considered one of the finest Argan forests in Morocco. Regrettably the dramatic decline at Ademine continues to the present, and recently the Ademine forest was largely destroyed by the construction of Agadir airport.

The local authorities have taken some protective measures, the most significant being the establishment in 1998 of the Réserve de biosphère de l'Arganeraie, part of the World Network of Biosphere Reserves (UNESCO-MAB). This large reserve (2.6 million ha) covers almost the entire Argan area from Essaouira in the north, to Ifni in the south and Taliouine in the east, and includes other protected areas, such as Souss-Massa National Park and some 12 Sites of Biological and Ecological Interest (SIBE) containing Argan habitats. Souss-Massa National Park (33,800 ha), created in 1991, includes several Argan stands, the largest being Rokein wood (250 ha: Rousseau 2000). Among other scheduled continental SIBES (AEFCS 1995a), the most important are Tafingoult on the southern slopes of the High Atlas (3,000 ha, the majority being well-preserved

Table 1. Changes in Argan habitat at Ademine from 1969 to 1986 (after M'Hirit *et al.* 1998)

Tableau 1. Changements dans l'habitat à Arganier à Ademine de 1969 à 1986 (d'après M'Hirit *et al.* 1998)

Type of habitat	Size (in ha)		Increase/decrease (in ha)
	1969	1986	
Dense Argan woodland (more than 40 trees / ha)	512	496	-16
Average Argan woodland (10–40 trees / ha)	10,272	3,472	-6,800
Average Argan woodland (10–40 trees / ha) with irrigated cultivation	400	3,856	+3,456
Light Argan woodland (fewer than 10 trees / ha)	10,448	8,304	-2,144
Light Argan woodland (fewer than 10 trees / ha) with irrigated cultivation	512	5,616	+5,104
Cultivations under glass	-	80	+80
Habitation	32	176	+144
Dunes	80	80	0
Reforestation	-	176	+176
Total size (in ha)	22,256	22,256	

Argan forest), Ademine in the Souss Valley (3,500 ha of open parkland Argan forest) and Jbel Imzi in the Anti-Atlas, where *Argania spinosa* occurs together with another Macaronesian endemic, *Dracaena dracco* (Benabid 2000). Cap Ghir, a coastal SIBE along the Atlantic seaboard (AEFCS 1995b) holds fine stands of Argan and is partly classed as an Important Bird Area (IBA of Tarhazoute; Magin 2001).

Breeding birds of the Argan woodland

Argan woodland forms an important habitat for birds. More than 40 species have been recorded breeding, including locally rare species, e.g. Dark Chanting Goshawk *Melierax metabates*, Black-shouldered Kite *Elanus caeruleus*, Tawny Eagle *Aquila rapax* and Black-crowned Tchagra *Tchagra senegalus*. Several Palearctic forest species, notably Wood Pigeon *Columba palumbus*, Hawfinch

Table 2. Regular breeding bird species in Argan woodland
Tableau 2. Espèces d'oiseaux nicheurs réguliers dans l'arganaie

Species		Nest site		
		On ground	In understory	In Argan trees
<i>Elanus caeruleus</i>	Black-shouldered Kite / Elanion blanc			x
<i>Melierax metabates</i>	Dark Chanting Goshawk / Autour sombre			x
<i>Aquila rapax</i>	Tawny Eagle / Aigle ravisseur			x
<i>Alectoris barbara</i>	Barbary Partridge / Perdrix gabra	x		
<i>Burhinus oedicnemus</i>	Stone-curlew / Oedicnème criard	x		
<i>Columba palumbus</i>	Wood Pigeon / Pigeon ramier			x
<i>Streptopelia turtur</i>	European Turtle Dove / Tourterelle des bois			x
<i>Clamator glandarius</i>	Great Spotted Cuckoo / Coucou geai			x
<i>Athene noctua</i>	Little Owl / Chevêche d'Athéna			x
<i>Strix aluco</i>	Tawny Owl / Chouette hulotte			x
<i>Caprimulgus ruficollis</i>	Red-necked Nightjar / Engoulevent à collier roux	x		
<i>Upupa epops</i>	Hoopoe / Huppe fasciée			x
<i>Galerida cristata</i>	Crested Lark / Cochevis huppé	x		
<i>Galerida theklae</i>	Thekla Lark / Cochevis de Thékla	x		
<i>Pycnonotus barbatus</i>	Common Bulbul / Bulbul des jardins			x
<i>Cercotrichas galactotes</i>	Rufous Scrub Robin / Agrobate roux		x	
<i>Phoenicurus moussieri</i>	Moussier's Redstart / Rougequeue de Moussier	x	x	x
<i>Oenanthe hispanica</i>	Black-eared Wheatear / Traquet oreillard	x		
<i>Turdus merula</i>	Eurasian Blackbird / Merle noir		x	x
<i>Sylvia hortensis</i>	Orphean Warbler / Fauvette orphée		x	x
<i>Sylvia melanocephala</i>	Sardinian Warbler / Fauvette mélanocéphale		x	x
<i>Sylvia conspicillata</i>	Spectacled Warbler / Fauvette à lunettes		x	
<i>Sylvia deserticola</i>	Tristram's Warbler / Fauvette de l'Atlas		x	
<i>Muscicapa striata</i>	Spotted Flycatcher / Gobemouche gris			x
<i>Turdoides fulva</i>	Fulvous Babbler / Cratérope fauve		x	
<i>Parus major</i>	Great Tit / Mésange charbonnière			x
<i>Parus [caeruleus] teneriffae</i>	African Blue Tit / Mésange maghrébine			x
<i>Lanius meridionalis</i>	Southern Grey Shrike / Pie-grièche méridionale		x	x
<i>Lanius senator</i>	Woodchat Shrike / Pie-grièche à tête rousse			x
<i>Tchagra senegalus</i>	Black-crowned Tchagra / Tchagra à tête noire		x	x
<i>Pica pica</i>	Common Magpie / Pie bavarde			x
<i>Garrulus glandarius</i>	Eurasian Jay / Geai des chênes			x
<i>Sturnus unicolor</i>	Spotless Starling / Etourneau unicolore			x
<i>Passer hispaniolensis</i>	Spanish Sparrow / Moineau espagnol		x	x
<i>Fringilla coelebs</i>	Common Chaffinch / Pinson des arbres			x
<i>Serinus serinus</i>	European Serin / Serin cini			x
<i>Carduelis chloris</i>	European Greenfinch / Verdier d'Europe			x
<i>Carduelis carduelis</i>	European Goldfinch / Chardonneret élégant		x	x
<i>Carduelis cannabina</i>	Common Linnet / Linotte mélodieuse		x	
<i>Bucanetes githagineus</i>	Trumpeter Finch / Roselin githagine	x		
<i>Coccothraustes coccothraustes</i>	Hawfinch / Gros-bec casse-noyaux			x
<i>Emberiza cia</i>	Rock Bunting / Bruant fou	x	x	
<i>Emberiza cirius</i>	Cirl Bunting / Bruant zizi	x		
<i>Miliaria calandra</i>	Corn Bunting / Bruant proyer		x	

Coccothraustes coccothraustes and Common Chaffinch *Fringilla coelebs*, reach the southern limit of their range.

In the Souss region, where the main areas of Argan woodland occur, its breeding birds were first investigated by Lynes (1925) in May/June 1924, but he gave few details of the species he found. During the 1940s, the Heim de Balsacs (1954) travelled through the Argan area in south-west Morocco, but again gave few details on the avifauna. The first ornithologists to draw attention to the importance of the Argan habitat were D. & J. Bannerman, who identified 32 species during a short visit south of Essaouira (Bannerman & Bannerman 1953). To our knowledge, however, no detailed ornithological surveys have been published prior to the recent field studies of Rousseau (2000). R. E. Moreau (1966) did not even mention it as an important African habitat. Since then, however, enough detailed information has been gathered to assess the importance to birds of this habitat, which is also of known importance for its plants and for mammals, reptiles, amphibians and invertebrates, e.g. Lepidoptera (Mellado 1989, TARRIER & BENZYANE 2003). Table 2 lists the birds known as regular breeding species in Argan forest.

As in other forest habitats, bird species richness in Argan is closely related to vegetation structure, which depends on climatic and physical variables (soil, aspect, etc.) but also on human uses (grazing, ploughing, etc.). Argan woodland is less rich in species than the more humid oak and cedar woodlands of northern Morocco, which hold the highest number of breeders (SNOW 1952, THÉVENOT 1982). However, the 42–46 species confirmed to breed in the Argan is close to the figure of c.45–50 species in semi-arid lowland cork oak forest of northern Morocco (THÉVENOT 1991) or the 42–45 species (excluding raptors) given by FINLAYSON (1992) for lowland oak woods in southern Spain.

Many species occurring in the moister woodlands of northern Morocco do not penetrate the semi-arid Argan woodland south of the High Atlas, as this range forms a biogeographical barrier (ROUX 1996). These include Eurasian Sparrowhawk *Accipiter nisus*, Eurasian Hobby *Falco subbuteo*, Stock Dove *Columba oenas*, Great Spotted Woodpecker *Dendrocopos major*, Levaillant's Woodpecker *Picus vaillantii*, Woodlark *Lullula arborea*, European Robin

Table 3. Relative frequency of breeding species recorded in Argan woodland in Souss-Massa National Park and Ademine forest in 1994–95 (Rousseau 2000)

Tableau 3. Fréquence relative des espèces nicheuses notées dans l'arganeraie du Parc national de Souss-Massa et de la Forêt d'Ademine en 1994–95 (Rousseau 2000)

	Souss-Massa NP	Ademine forest
Number of point counts (EFP)	34	22
Total number of bird species	26	24
Mean number of species/point count	10.7	11.3
Shannon's diversity Index (H')	4.24	4.34
Bird species	Relative frequency	
<i>Alectoris barbara</i>	0.21	0
<i>Burhinus oedipnemos</i>	0.21	0.14
<i>Columba palumbus</i>	0.18	0.45
<i>Streptopelia turtur</i>	0.82	0.82
<i>Clamator glandarius</i>	0	0.09
<i>Athene noctua</i>	0.15	0.04
<i>Strix aluco</i>	0.06	0
<i>Upupa epops</i>	0.33	0.41
<i>Galerida theklae</i> and <i>G. cristata</i>	0.54	0.95
<i>Pycnonotus barbatus</i>	0.18	0.45
<i>Cercotrichas galactotes</i>	0.03	0
<i>Phoenicurus moussieri</i>	0.57	0.82
<i>Turdus merula</i>	0.64	0.68
<i>Sylvia melanocephala</i>	0.67	0.45
<i>Muscicapa striata</i>	0.06	0
<i>Parus major</i>	0.3	0.5
<i>Parus [caeruleus] teneriffae</i>	0.06	0
<i>Lanius meridionalis</i>	0.75	0.14
<i>Lanius senator</i>	0.45	0.54
<i>Tchagra senegalus</i>	0.09	0.18
<i>Pica pica</i>	0.75	0.59
<i>Passer domesticus</i>	0.48	0.59
<i>Fringilla coelebs</i>	0	0.54
<i>Serinus serinus</i>	0.3	0.64
<i>Carduelis chloris</i>	0.42	0.77
<i>Carduelis carduelis</i>	0.36	0.77
<i>Carduelis cannabina</i>	0.18	0.36
<i>Emberiza cirrus</i>	0	0.09
<i>Millaria calandra</i>	0.03	0.04

Erithacus rubecula, Common Redstart *Phoenicurus phoenicurus*, Mistle Thrush *Turdus viscivorus*, Firecrest *Regulus ignicapilla*, Atlas Flycatcher *Ficedula (hypoleuca) speculigera*, Coal Tit *Parus ater*, Eurasian Nuthatch *Sitta europaea* and Short-toed Treecreeper *Certhia brachydactyla*.

Rousseau (2000) undertook a bird census, in 1994–95, in Argan woodland within Souss-Massa National Park and the Ademine forest, using point counts (frequentation sampling EFP: see Blondel 1975). The results are summarised in Table 3. He recorded 30 species, the most frequent (in more

than 50% of census points; occurrence = 0.5) being European Turtle Dove *Streptopelia turtur*, Thekla/Crested Larks *Galerida theklae/cristata*, Moussier's Redstart *Phoeniculus moussieri*, Sardinian Warbler *Sylvia melanocephala*, Common Magpie *Pica pica*, European Greenfinch *Carduelis chloris* and European Goldfinch *C. carduelis*. Other regular species (occurrence between 0.49 and 0.30) included Wood Pigeon, Hoopoe *Upupa epops*, Great Tit *Parus major*, Southern Grey Shrike *Lanius meridionalis*, Woodchat Shrike *L. senator* and European Serin *Serinus serinus*.

Notes on selected species

All species below occur in habitat where Argan forms the dominant part of the natural vegetation. Excluded are species breeding in pre-desert steppe on the southern slopes of the Western Anti-Atlas and Lower Draa, where a few scattered Argan occur, often with *Acacia raddiana*, e.g. Cream-coloured Courser *Cursorius cursor*, Desert Lark *Ammomanes deserti* and Desert Wheatear *Oenanthe deserti*.

Black-shouldered Kite *Elanus caeruleus*

Local resident in open parkland, with most records from the Souss Valley. Threatened due to local disturbance and clearance of suitable habitat.

Dark Chanting Goshawk *Melierax metabates*

Very local resident (subspecies *theresae*, endemic to Morocco), now restricted to the Souss Valley and adjacent Anti-Atlas foothills. Already considered rare by Lynes (1925). Total population estimated at a few dozen pairs in the 1980s (Thévenot *et al.* 1985), but now probably much smaller and perhaps on the verge of extinction, due to further degradation and removal of Argan. Only proof of nesting was of fledged young on 22 June 1924 (Lynes 1925) and a pair at nest with young in an abandoned olive grove, 17–20 April 1979 (Heinze & Krott 1979).

Long-legged Buzzard *Buteo rufinus*

Fairly common resident in the early-20th century (Lynes 1925); now uncommon and mainly nests on cliffs. A breeding record in 1985 of a nest in Argan, on a steep rocky slope in Western Anti-Atlas (J. P. Marfin pers. comm.).

Tawny Eagle *Aquila rapax*

Rare and endangered resident, showing a continuous decline in the second half of the 20th century.

Now almost restricted to the Souss, Western High Atlas and Anti-Atlas. Nests in open areas of Argan, but breeding records few; most recent, all in April, were of pair at nest in Argan trees in 1980, 1990 and 1992. Numbers may be as low as a few dozen pairs.

Booted Eagle *Hieraetus pennatus*

Rare migrant breeder. A pair nested in the Souss Valley in Argan woodland near Taroudant in 1980 (Thévenot *et al.* 2001). Also nests on rocky cliffs at Aoulouz. These are the only breeding records south of the High Atlas.

Common Kestrel *Falco tinnunculus*

Common resident in open Argan woodland, but only occasionally nesting in trees, sometimes in an old nest of Common Magpie.

Barbary Partridge *Alectoris barbara*

Previously widespread and fairly common resident (*A. b. koenigi*), but has greatly declined through clearance of suitable habitat and excessive hunting and poaching.

Stone-curlew *Burhinus oedicnemus*

Fairly common resident in open Argan woodland, generally on flat or gently undulating areas with little understorey.

Black-bellied Sandgrouse *Pterocles orientalis*

Uncommon resident in the Souss, where it nests mostly in open steppe, but in the Anti-Atlas also in stony steppe with many *Euphorbia* and some *Argania* trees.

Wood Pigeon *Columba palumbus*

Uncommon resident (*C. p. excelsa*). Breeds in moderate numbers in the Souss and Haha regions in Argan, reaching the southern limit of its range in the Western Anti-Atlas near Ifni.

European Turtle Dove *Streptopelia turtur*

Common migrant breeder (*S. t. arenicola*), generally in open woodland. Very common in the early-20th century (Lynes 1925) and still common today, but may be under threat due to high hunting pressure. Occasionally recorded in winter.

Laughing Dove *Streptopelia senegalensis*

Recent immigrant, probably originating from Algeria (*S. s. phoenicophila*) rather than Mauritania (*S. s. senegalensis*). Mostly breeds in oases and orchards in the coastal Souss area, where regularly

sighted since 1988. Two singing males recorded once in a small Argan wood within Souss-Massa National Park (Rousseau 2000).

Great Spotted Cuckoo *Clamator glandarius*

Rare migrant breeder. Nesting long suspected in the region, but only proved in 1990, when eggs were found in a Common Magpie nest in the Souss Valley (Maumary & Dupperrex 1991). Seven subsequent breeding records, all in Common Magpie nests in Argan habitat, in the Souss and in foothills of the Western High Atlas (near Tafingoult), and the Western Anti-Atlas (northwest of Goulimine). First migrants arrive in late November and leave as early as July.

Desert Eagle Owl *Bubo [bubo] ascalaphus*

Rare resident. In the Argan, known only from ravines in the Abda region.

Little Owl *Athene noctua*

Common resident throughout the Argan area, notably in the Souss and Anti-Atlas (*A. n. glaux*); also locally common in the Lower Draa (*A. n. saharae*). Mostly in open woodland, where it nests in holes of old trees and in stone piles.

Tawny Owl *Strix aluco*

Common and widespread resident in the Souss, where it reaches the southern limit of its range. Occurs in different habitats, notably in Argan woodland, where not rare. A nest was found in an Argan tree in Rokein wood, Souss-Massa National Park, in spring 1995 (Rousseau 2000).

Red-necked Nightjar *Caprimulgus ruficollis*

Common and widespread migrant breeder throughout the area (*C. r. ruficollis*), almost entirely in flat, open areas of Argan. Occasionally recorded in winter.

Hoopoe *Upupa epops*

Locally common migrant breeder in open Argan woodland, nesting in tree holes. Early spring migrants occur from late December.

Crested Lark *Galerida cristata*

Uncommon resident in the Souss Valley (*G. c. rignenbachi*), where restricted to areas of cereals within Argan habitat or in adjacent cereals where woodland has been cut. Occasionally observed singing from Argan trees.

Thekla Lark *Galerida theklae*

Common and widespread resident in the northern Argan area, south to the Souss (*G. t. ruficolor*) and further south in the Western Anti-Atlas (*G. t. aguirrei*). Mostly on stony ground, either in flat valleys or on lower and upper hillsides. In transects, in 1981, in the Souss Valley, highest numbers occurred on lower hill slopes (Vernon & Chadwick unpubl.). Regularly observed singing from Argan trees.

Common Bulbul *Pycnonotus barbatus*

Common and widespread in the Western High Atlas, Souss and Anti-Atlas, where particularly abundant in riparian vegetation, gardens, and olive and citrus orchards; also regularly recorded in Argan habitat but a nest in an Argan tree has yet to be found.

Winter Wren *Troglodytes troglodytes*

Probably a very local resident. Very rarely recorded in the Argan area, where its breeding status requires confirmation. During the breeding season, reported twice in the Western Anti-Atlas from Jbel Kest near Tafraout, once in the Central Anti-Atlas in the Assads Valley and once in the Souss at Freija, east of Taroudant (Thévenot *et al.* 2003). Probably restricted to moist areas, probably only near watercourses.

Rufous Scrub Robin *Cercotrichas galactotes*

Common migrant breeder in Argan habitat in the Souss. Also occurs at low altitudes in the Haha and Western High Atlas and breeds locally in the Western Anti-Atlas and the Lower Draa. Occurs in open Argan woodland with or without scrub undergrowth, although more abundantly in bushy vegetation along rivers. Nests in bushes.

Moussier's Redstart *Phoenicurus moussieri*

Common and locally abundant in coastal areas, from Talmest, Western High Atlas, in the north, to Ifni, Western Anti-Atlas, in the south. Also common inland in the Souss Valley east to Aoulouz. Occurs in open Argan habitat throughout. Nest is placed on the ground, sheltered by a low bush or tussock, in the side of a low bank, under thorn scrub or within dense bushes including Argan or up to 3 m in Argan trees. Castell (2000) noted that 50% of the 30 nests found around Agadir were in tree forks.

Black-eared Wheatear *Oenanthe hispanica*

Fairly common migrant breeder (*O. b. hispanica*). Generally in Argan habitat with some undergrowth, on both flat areas and lower stony hill-sides. Nests on the ground, under stones or at the base of bushes.

Eurasian Blackbird *Turdus merula*

Common resident (*T. m. mauritanicus*, endemic to north-west Africa) throughout Atlantic Morocco, in Argan habitat south to the Souss and southern slopes of the Anti-Atlas. Nests in bushes (e.g. *Ziziphus*) and in Argan trees up to 4 m.

Orphean Warbler *Sylvia hortensis*

Uncommon migrant breeder in the Souss and Anti-Atlas. Nests in bushes and trees within Argan habitat. Transects in May 1981 revealed that most occurred on upper slopes with bushy undergrowth (Vernon & Chadwick unpubl.).

Sardinian Warbler *Sylvia melanocephala*

Common resident in Atlantic Morocco including the Souss, but uncommon and local further south in the Western Anti-Atlas. Also common in foothills of the Western High Atlas to at least 1,500 m. Occurs in coastal Argan including open old parkland devoid of understorey (Rousseau 2000). Inland in the Souss more common on upper slopes with bushy undergrowth, in which it nests; also occasionally nests in low Argan bushes.

Subalpine Warbler *Sylvia cantillans*

Uncommon migrant breeder which reaches the southern limit of its range on the southern slopes of the Western High Atlas, where regularly recorded in open Argan bush, e.g. in the Tafingoult area, but proof of breeding is lacking. Formerly reported breeding further south near Aneja in the Western Anti-Atlas (Heim de Balsac & Heim de Balsac 1954).

Spectacled Warbler *Sylvia conspicillata*

Quite common migrant breeder, mostly in the Souss, in open Argan habitat wherever there are scattered bushes, especially *Ziziphus*, in which the nest is built. Occurs on rocky slopes, but more common in lower areas.

Tristram's Warbler *Sylvia deserticola*

Rare resident (*S. d. maroccana*, endemic to Morocco). Breeds on stony, uneven ground in open Argan bush in the Haha and Western High

Atlas. Only recently, in the 1980s, proved to breed in the Western Anti-Atlas at Tanalt and Adra Mqorn, on the upper slopes with open Argan bush (Thévenot *et al.* 2003). The nest is placed 0.3–1.5 m above ground in a bush.

(Western) Bonelli's Warbler *Phylloscopus bonelli*

Possible migrant breeder. No proof of breeding despite regular sightings on the upper slopes with Argan between the Souss Valley and the foothills of the Western High Atlas, e.g. near Tafingoult and Aoulouz. Breeds in the Western High Atlas.

Spotted Flycatcher *Muscicapa striata*

Fairly common migrant breeder in Argan habitat in the High Atlas and the Souss. Its southern limit is on the northern slopes of the Western Anti-Atlas. A nest 3 m above ground in an Argan tree, south of Souk Et-Tleta Akhssas (at c.29°15'N), is the southernmost breeding record.

Fulvous Babbler *Turdoides fulva*

Uncommon resident (*T. f. maroccana*, restricted to Morocco and north-west Algerian Sahara). Local resident confined to areas with dense bushes, especially *Ziziphus lotus*. May become rarer, especially in the Souss Valley, as much undergrowth is being removed.

Great Tit *Parus major*

Fairly common resident (*P. m. excelsus*, endemic to North Africa). Widespread in Argan habitat in the Haha and Western High Atlas and still common in the Souss, but more local further south in the Western Anti-Atlas, between Ifni and Tafraout. Occurs on all slopes in the foothills and to 1,200 m in the Anti-Atlas.

African Blue Tit *Parus [caeruleus] teneriffae*

Uncommon resident (*P. t. ultramarinus*, endemic to North Africa). Occurs in Argan woodland in the Haha, Western High Atlas, Souss and Western Anti-Atlas as far south as Tiznit. Common in the Souss Valley during transects in May 1981, but less so than Great Tit (Vernon & Chadwick unpubl.).

Southern Grey Shrike *Lanius meridionalis*

Common resident (*L. m. algeriensis*, restricted to north-west Africa). One of the commonest species throughout the Argan area, mainly in open woodland with or without thornbush undergrowth. Occurs mainly on flat lowland areas, with far

fewer pairs on lower montane slopes. Nests in bushes (especially *Ziziphus*) or Argan trees up to c.3 m above ground from late February, with fledged young from late March.

Woodchat Shrike *Lanius senator*

Common migrant breeder (*L. s. rutilans*), arriving mainly in April and nesting from late April/early May. Generally more common throughout the Argan region than Southern Grey Shrike, but mainly nests higher on lower slopes. Nests generally in Argan trees up to 5 m above ground.

Black-crowned Tchagra *Tchagra senegalus*

Uncommon and extremely local resident (*T. s. cucullatus*, endemic to north-west Africa). Occurs in low numbers throughout the Argan area, from Tafelney and Haha in the north to the Ifni area, Western Anti-Atlas, in the south. In the Souss it breeds inland east to Aoulouz and in neighbouring areas of the Western High Atlas, but highest numbers occur near the coast, in thickets near Tamri and at the Souss and Massa estuaries.

Common Magpie *Pica pica*

Common resident (*P. p. mauritanica*, endemic to north-west Africa) throughout Argan habitat. Fairly common in the northern part of the Argan range and in the Souss as far south as Tiznit; more thinly distributed in the Western Anti-Atlas, where it breeds in coastal areas near Ifni and also inland near Tafraout; even more local in the Lower Draa. Occurs mainly in open areas of Argan, generally with some thornbush undergrowth. Nests generally in a thorn bush up to 5 m above ground and occasionally in Argan trees.

Eurasian Jay *Garrulus glandarius*

Rare and very local resident (*G. g. minor*). Once recorded in Argan, in Jbel Hadid in Chiadma, and occasionally further south in the Anti-Atlas. A winter record near Tafraout and two breeding-season records: a pair in Argan woodland near Arba Ait-Ahmed in the upper Massa Valley and a single near Souk El Arba d'Assads, both in May 1985 (Thévenot *et al.* 2003).

Common Raven *Corvus corax*

Fairly common resident throughout the Argan range, where tree nesting likely occurs, although most recent breeding records are on cliffs.

Spotless Starling *Sturnus unicolor*

Uncommon to locally common resident. South of the High Atlas restricted to the Souss, where common in the Souss Valley east to Aoulouz and south to Tiznit. Probably nests in holes in Argan trees, as it is often seen in Argan woodland, but no proof as yet.

House Sparrow *Passer domesticus*

Common resident in towns and villages in the Souss and has recently spread south to Goulimine and Tantan in the Lower Draa. Occasionally nests some distance from human dwellings in low bushes and trees. A colony in Argan trees in the Souss Valley in May 1981 (Vernon & Chadwick unpubl.).

Spanish Sparrow *Passer hispaniolensis*

Colonies recorded in the Souss in Argan habitat, both in trees and in *Ziziphus* scrub, but nesting sporadic and numbers have declined considerably in many areas since the 1980s. Some hybridisation with House Sparrow occurs. Winter roosts in *Argania spinosa* and *Ziziphus lotus*.

Common Chaffinch *Fringilla coelebs*

Common resident (*F. c. africana*) throughout the Argan habitat, especially in the Souss and on western slopes of the High and Anti-Atlas, where it reaches its southern limit in the Bou-Izakarn area. Nest built in Argan trees, usually 3–7 m above ground.

European Serin *Serinus serinus*

Fairly common resident in the northern part of the Argan range and in the Souss, but more local in the southern foothills of the Anti-Atlas and in the Lower Draa. Often in Argan woodland, but proof of nesting there is lacking.

European Greenfinch *Carduelis chloris*

Common resident (*C. c. vooussi*, endemic to central Morocco and Algeria) in Argan habitat throughout the Haha region, the southern slopes of the Western High Atlas and in the Souss, reaching its southern limit in the Western Anti-Atlas. In the Souss one of the commonest passerines in Argan woodland, often more common on upper slopes.

European Goldfinch *Carduelis carduelis*

Ubiquitous and fairly common resident throughout the Argan range. Especially common in the

Souss, with some pairs breeding as far south as Goulimine in the Lower Draa.

Common Linnet *Carduelis cannabina*

Uncommon resident in Argan woodland in the Souss Valley east to Aoulouz, but more common in the coastal area. Very rare further south in the Western Anti-Atlas.

Trumpeter Finch *Bucanetes githagineus*

Common resident on stony hillsides covered with scattered scrub and Argan bush in the Anti-Atlas; more local in similar habitat in the Souss and Western High Atlas.

Hawfinch *Coccothraustes coccothraustes*

Rare resident (*C. c. buvryi*, endemic to north-west Africa). Rarely recorded in Argan habitat, but occurs therein in the Western High Atlas valleys, always near permanent water. Some breeding-season records further south in the Souss and Western Anti-Atlas near Tafraout, but no nesting records, except for one in a town park at Taroudant (Thévenot *et al.* 2003).

Rock Bunting *Emberiza cia*

Common resident in rocky habitats, including open Argan bush. Local in the Souss Valley, where restricted to rocky hillsides, but widespread in small numbers throughout the Anti-Atlas.

Cirl Bunting *Emberiza cirlus*

Uncommon resident in open Argan, almost entirely on upper slopes with sparse vegetation. Occurs on the southern slopes of the Western High Atlas, in the Souss, the Western Anti-Atlas and south to the Lower Draa. Nest generally placed near the ground in a tussock, occasionally up to 0.6 m above ground in a bush.

Corn Bunting *Miliaria calandra*

Occasional resident in open Argan parkland under corn cultivation, but also at the edge of small areas of Argan woodland in the north of its range (Haha region and High Atlas) and in the Souss, especially in coastal areas, but absent from the Anti-Atlas further south.

Migrant and wintering birds

The Argan habitat permits many European birds to overwinter further south in Morocco than inland, where they encounter the barriers of the desert and the treeless wastes of the High Plateaux

(although a few penetrate the river valleys of the Draa, Dadès and Ziz to winter in the oases there). Numerous Song Thrushes *Turdus philomelos*, Blackcaps *Sylvia atricapilla*, Common Chiffchaffs *Phylloscopus collybita*, European Starlings *Sturnus vulgaris* and a few European Robins *Erithacus rubecula* are found wintering. Large flocks of finches wander in open Argan woodland where the soil has been cultivated, notably European Serin, European Greenfinch, European Goldfinch and Common Linnet. Most of these are Moroccan-bred birds, but a few originate in Europe. Numbers vary from year to year, depending partially on weather conditions in southern Europe and the presence or absence of rains in the Argan area between October and March. A few Redwings *Turdus iliacus*, Common Chaffinches *Fringilla coelebs* and, occasionally, Bramblings *F. montifringilla*, reach Argan woodlands in some winters, following cold-weather movements in Europe. Eurasian Siskins *Carduelis spinus* regularly reach the Souss during major irruptions from Europe. In spring and autumn European migrants pass through the Argan area en route to breeding and wintering areas. These include European Turtle Dove, European Roller *Coracias garrulus*, European Bee-eater *Merops apiaster*, Tree Pipit *Anthus trivialis*, Whinchat *Saxicola rubetra*, Common Redstart, various warblers, Pied Flycatcher *Ficedula hypoleuca*, Eurasian Golden Oriole *Oriolus oriolus* and Ortolan Bunting *Emberiza hortulana*.

Conservation of the Argan woodland

Vernon (1980) was among the first to draw attention to the importance of Argan habitat for birds, and to recommend its conservation. Mellado (1989) subsequently pointed out the importance of the Argan ecosystem for reptiles, birds and mammals, and proposed a detailed assessment of conservation requirements for the habitat. Most recently, Tarrier & Benzyane (2003) surveyed the butterfly fauna and noted that habitat destruction was continuing. However, several programmes promoting the sustainable harvesting of Argan oil have been recently initiated and are a possible hope for maintaining the Argan habitat

Emberger (1939) estimated the Argan ecosystem to cover 650,000 ha. This must be considerably less today, as much has been removed in the lowlands. As early as the 1920s, when Lynes visit-

ed the Souss region, much of the Argan in the Lower Souss had been cleared and replaced by olive and citrus groves. This process has since accelerated and the original ecosystem has lost 50% of its area during the last century as a result of human activities (overgrazing and deforestation) and climatic effects (drought and desertification). Like most other woodland areas in Morocco, Argan woodland on private and public land is the responsibility of the government (namely the 'Haut Commissariat aux Eaux et Forêts et à la Lutte contre la Désertification'). Yet illegal logging is widespread and Argan woodland in the Souss Valley is now highly fragmented. This fragmentation affects the survival of the critically endangered North African population of Dark Chanting Goshawk and Tawny Eagle, both almost restricted to the Souss Valley. Although Dark Chanting Goshawk might already be extinct, there is hope that small numbers still survive. Surveys are urgently required to ascertain the status of these species and undertake appropriate conservation measures.

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this paper was at an advanced stage in the editorial process, Rae Vernon passed away. His many contributions to Moroccan ornithology are remembered by his fellow authors, who take the opportunity to dedicate this paper, devoted to a habitat he dearly loved, to Rae's memory.

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Captions to figures on on this and opposite pages

Figure 1. Argan in the Haha region, with *Senecio antheuphorbium*, May 2004 (P. Bergier)

L'arganeraie dans la région des Haha, avec *Senecio antheuphorbium*, mai 2004 (P. Bergier)

Figure 2. Argan under barley cultivation, Souss region, May 2004 (P. Bergier)

Culture de céréales sous Arganiers dans le Souss, mai 2004 (P. Bergier).

Figure 3. Open Argan forest, Western High Atlas, May 2004 (P. Bergier)

Arganeraie lâche sur les contreforts du Haut Atlas Occidental, mai 2004 (P. Bergier)

Figure 4. Old Argan tree, Souss-Massa National Park, May 1995 (E. Rousseau)

Vieil Arganier dans le Parc national de Souss-Massa, mai 1995 (E. Rousseau)

Figure 5. Open Argan parkland, Souss Valley (P. Bergier)

Arganeraie ouverte dans le Souss (P. Bergier)

Figure 6. Degraded Argan woodland, near Taroudant, under barley and with goats, April 1967 (R. Vernon)

Arganeraie dégradée près de Taroudant, avec culture de céréales et chèvres, avril 1967 (R. Vernon)

Figure 7. Nest and eggs of Red-necked Nightjar *Caprimulgus ruficollis*, near Aoulouz, May 1981 (R. Vernon)

Ponte d'Engoulevent à collier roux *Caprimulgus ruficollis* près d'Aoulouz, mai 1981 (R. Vernon)

Figure 8. Thekla Lark *Galerida theklae*, singing from atop an Argan tree, May 1981 (R. Vernon)

Cochevis de Thekla *Galerida theklae* chantant au sommet d'un Arganier, mai 1981 (R. Vernon)

Figure 9. Moussier's Redstart *Phoenicurus moussieri*, widespread and locally common throughout open Argan habitat, December 1987 (A. van den Berg)

Le Rougequeue de Moussier *Phoenicurus moussieri* est largement répandu et localement commun dans l'arganeraie, décembre 1987 (A. van den Berg)



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